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ABSTRACT

This booklet for children emphasizes the exploration and protection of the environment. An introduction discusses the interaction between humankind and the environment, emphasizing that the earth is a closed system. Chapter 1, "Mission: Protect the Water," addresses human dependence on water, water pollution, and water treatment. Chapter 2, "Mission: Protect the Air," contains information on air pollution, air pollution abatement, and relatively new problems such as acid rain and radon gas in homes. Chapter 3, "Mission: Protect the Land," deals with hazardous wastes and solid wastes. Chapter 4, "Mission: Safer Use of Pesticides," discusses the use of pesticides on farms and around the home, the resistance or "R" factor, and how to protect oneself from pesticides. Chapter 5, "Mission: Safer Use of Toxic Substances," looks at the problem of what constitutes unsafe dosages of toxic substances and provides a toxic "hit list." Throughout the booklet are information, experiments, activities, and questions and answers about the topic at hand. The appendices include information about the Environmental Protection Agency (EPA) and federal and state laws, and a glossary of terms. (TW)

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Explore Your Environment

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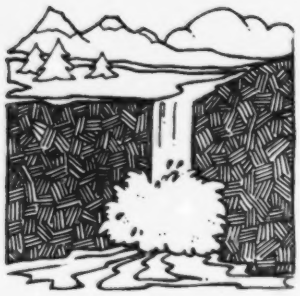

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INTRODUCTION

What does the environment have to do with you?

Your birth made an impact on the world. You were a new person for the world to feed, clothe, and shelter.

Today, you are still making an impact on the world. When you turn on the TV or turn up the heat in your home, you use energy—gas, oil, or electricity. When you bite into a hamburger from a fast food restaurant, you benefit from the work of the farmers who raised the beef cattle and the industries that made the burger packaging.

The way that people produce food, energy, and other resources you enjoy can keep your environment wholesome and clean, or make it dirty and polluted.

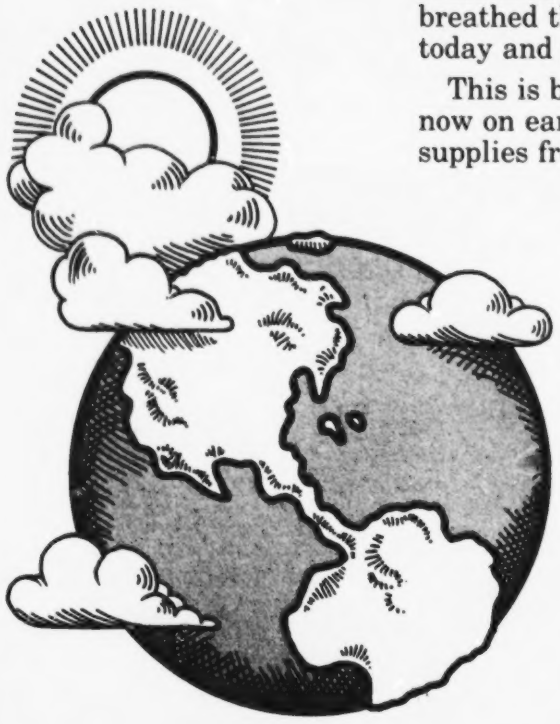
The way that you use those resources can also affect the environment. You decide what products to buy, what to repair, what to throw away. As you grow up, you will also decide about laws and government policy. Your decisions can make the environment better or worse.

A closed system

You have something in common with Egypt's King Tut, who lived thousands of years ago, and with Britain's Queen Elizabeth, who is living today.

It seems incredible that people so far apart in time and space could share anything at all. But anyone who has ever lived has breathed the same air and used the same water that you use today and your children will use in the future.

This is because earth is a closed system. The air and water now on earth have always been here. Earth gets no new supplies from space.



Nature uses air and water again and again. This is called recycling. Energy in the form of sunlight provides the power for recycling by nature.

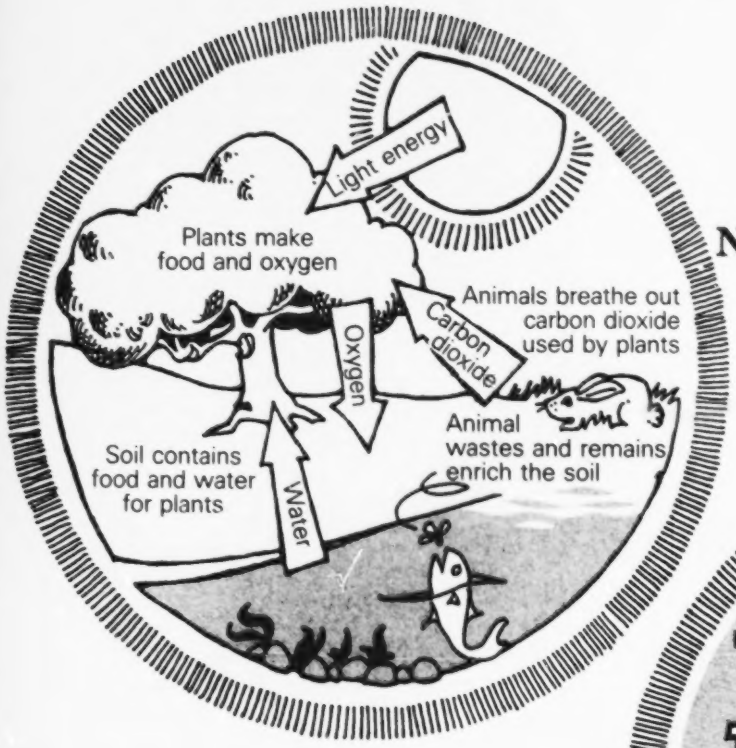
Take water, for example. It falls to the ground as rain or snow. From there some of the water soaks deep into the ground and becomes ground water. Some runs off the land into rivers and lakes and becomes surface water. Sooner or later both the surface water and much of the ground water reach the ocean. At the surface of the ocean and the land, heat from the sun evaporates water. It rises as vapor into the air to make clouds. Eventually, the very same water falls back to earth as rain or snow, and the cycle begins again.

When you pour a glass of water down a drain in your house, it goes through underground pipes, and eventually rejoins the never-ending cycle of water from land to air and back again.

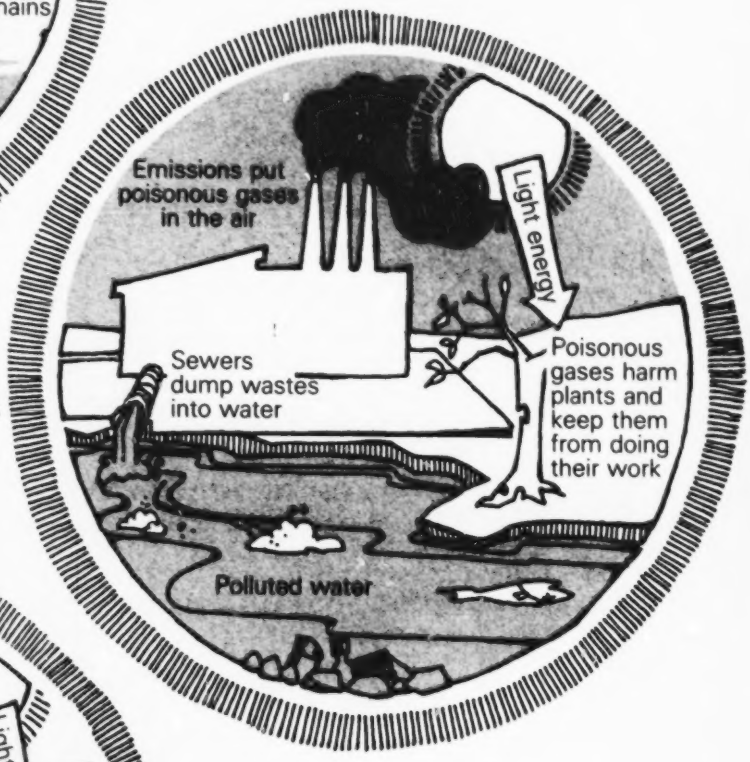
The same is true of the air we breathe. No "new" air is ever added to earth. Instead, green plants clean "used" air. To grow, plants use sunlight and the carbon dioxide that people and animals breathe out, and they produce the oxygen we need to breathe in. The same air has been used over and over again, for thousands of years, by dinosaurs, King Tut, Queen Elizabeth, and you.

Nature's way of recycling resources like air and water has always worked very well. But in the last hundred years or so, things have become more complicated. Factories and cars burn fuel that dirties the air. People have learned how to make things like plastics and chemicals that nature cannot recycle. These materials can dirty the land and water.

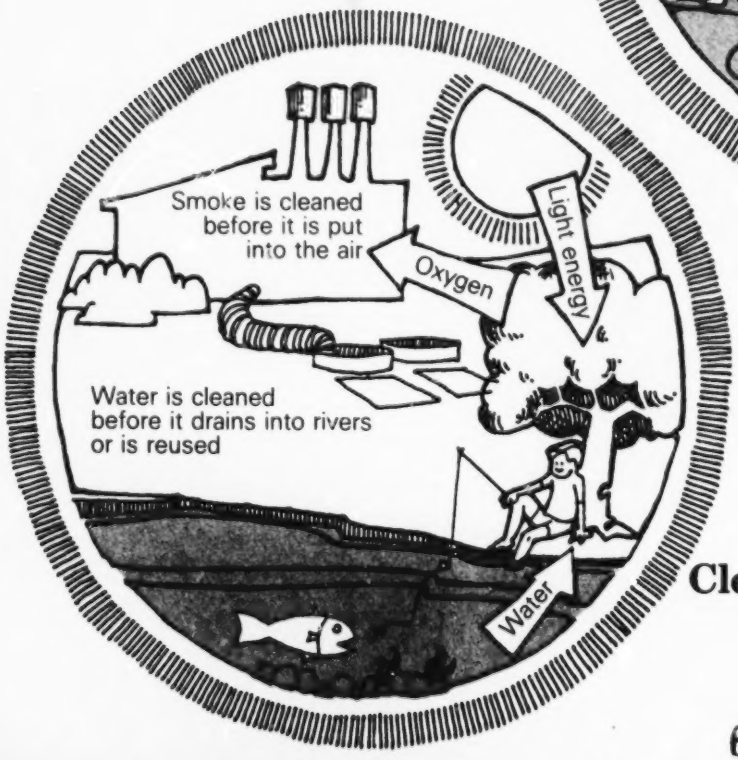
The number of people on earth is always growing. More people need more things: more food, more houses, more cars. Making these things will produce more pollution, unless people control it. So it is important to remember one thing: if people create pollution, they *can* also control it.


Light energy
Plants make food and oxygen
Animals breathe out carbon dioxide used by plants
Carbon dioxide
Oxygen
Animal wastes and remains enrich the soil
Soil contains food and water for plants
Water

Natural Environment


Emissions put poisonous gases in the air
Light energy
Sewers dump wastes into water
Poisonous gases harm plants and keep them from doing their work
Polluted water

Polluted Environment


Smoke is cleaned before it is put into the air
Oxygen
Light energy
Water is cleaned before it drains into rivers or is reused
Water

Cleaned Environment

CHAPTER 1

Mission: Protect The Water

Try these questions (correct answers at end of chapter):

1. How much water do you and your family use each day?

2. How much water is used to make a ton of steel?

Life depends on water

Don't take water for granted. You can't live without it. To begin with, your body is about two-thirds water. You need to take in about a quart of water a day to replace the water you lose naturally. (Big animals like horses need about 15 gallons of water a day!)

You need water for cleaning and gardening. Water is also needed to produce your food. Farmers depend on water to grow crops and raise animals. Believe it or not, it takes about 115 gallons of water to grow wheat for one loaf of bread, about 120 gallons to care for a chicken to lay one egg, and about 4,000 gallons to produce a pound of beef.

Power plants use water for cooling. And factories use water to make the kinds of things you and your family use — things like clothing and paper and gasoline and steel for cars.

Ships carry goods and people around the world on water. People go swimming, boating, and fishing in water. And many animals and plants live in water.

Most of the earth's water is salt water in oceans. Less than one percent of all the water on earth is useable fresh water—in lakes, rivers, and underground aquifers.

The supply of fresh water is limited, but life is not possible without it. That is why it is so important to keep water clean and useable.

Water pollution

At one time, factories dumped untreated waste directly into water. Sometimes they dumped it on the land, where it could seep into ground water. Even today, accidents on ships and off-shore drilling rigs spill oil into the oceans. Animal waste runoff from livestock feedlots seeps into ground water. Fertilizers and pesticides wash off from fields and forests and soak into ground water. Wastes from mines drain into water. People flush sewage down household pipes into the water.

The result of all this is water pollution. Sometimes you can see garbage floating in polluted water. Sometimes polluted water smells, or looks muddy or too ugly for swimming or boating. But even water that looks clean and smells good can be polluted. It may be loaded with germs and dangerous chemicals that you cannot see or smell.

Polluted water is unsafe for drinking, bathing, or swimming. If you eat a fish that lived in polluted water, you can absorb from the fish the same poisons that the fish absorbed from the water. In polluted water, many fish and plants cannot live at all.

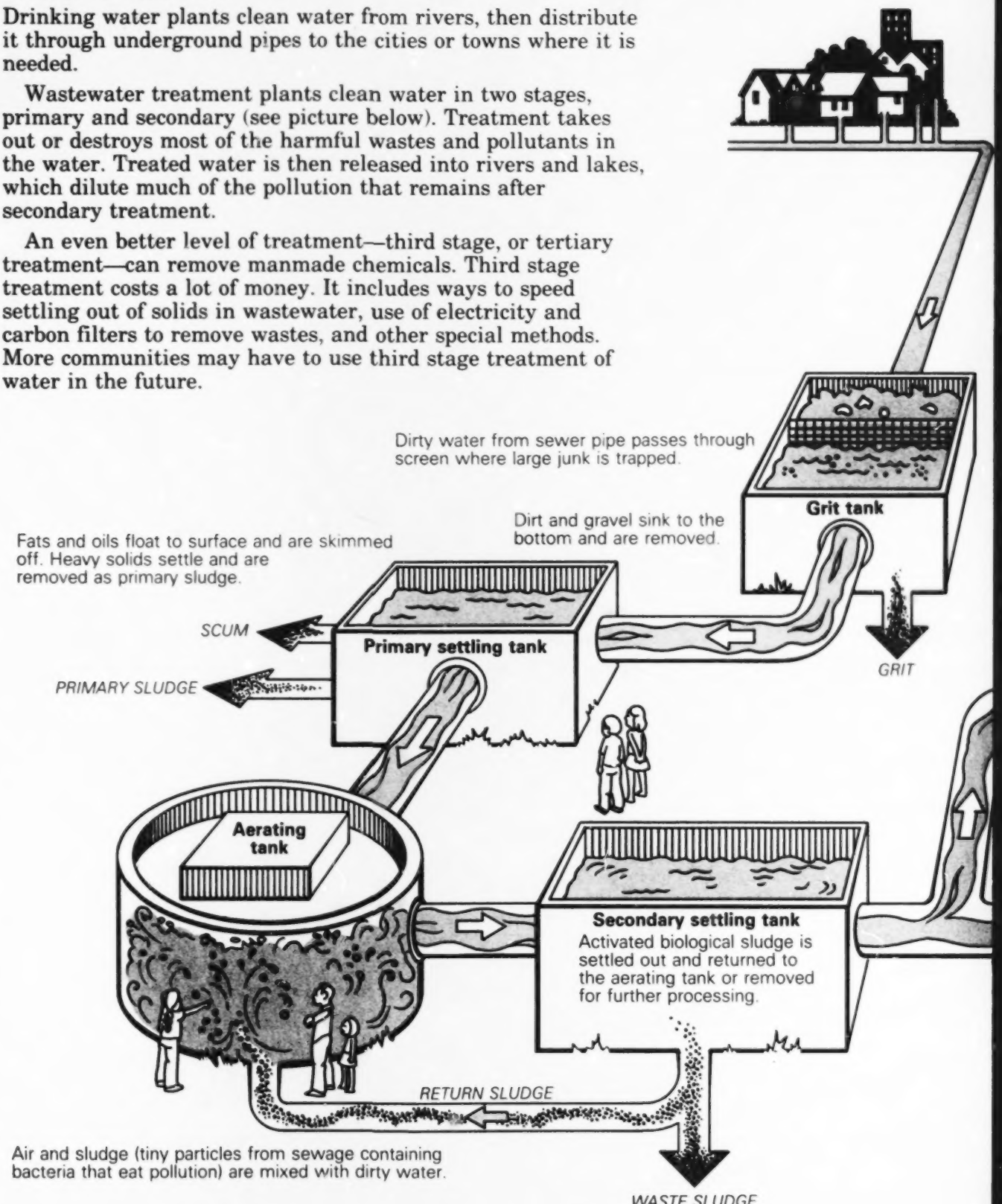
Nature recycles fresh water. But nature can only do so much! We are putting more wastes into water than nature can handle alone. We need to help nature clean water.

Water treatment

Drinking water plants clean water from rivers, then distribute it through underground pipes to the cities or towns where it is needed.

Wastewater treatment plants clean water in two stages, primary and secondary (see picture below). Treatment takes out or destroys most of the harmful wastes and pollutants in the water. Treated water is then released into rivers and lakes, which dilute much of the pollution that remains after secondary treatment.

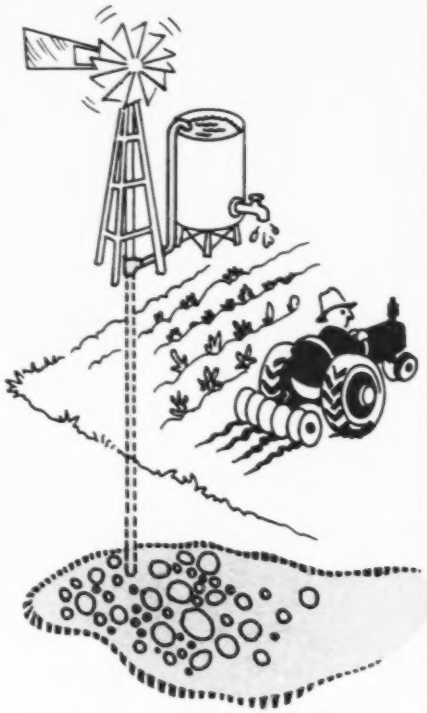
An even better level of treatment—third stage, or tertiary treatment—can remove manmade chemicals. Third stage treatment costs a lot of money. It includes ways to speed settling out of solids in wastewater, use of electricity and carbon filters to remove wastes, and other special methods. More communities may have to use third stage treatment of water in the future.

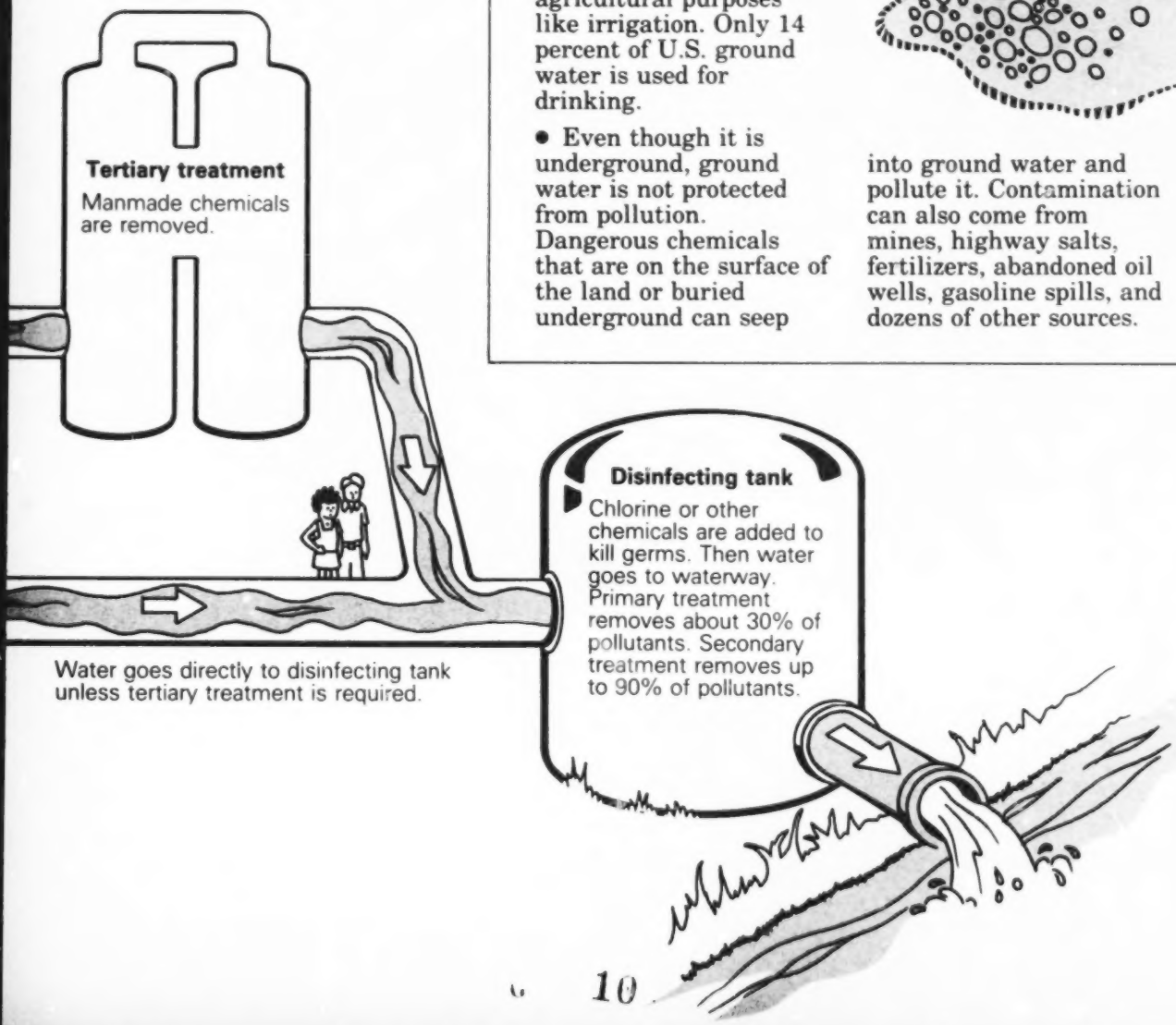

Dirty water from sewer pipe passes through screen where large junk is trapped.
Grit tank
Dirt and gravel sink to the bottom and are removed.
GRIT
Fats and oils float to surface and are skimmed off. Heavy solids settle and are removed as primary sludge.
SCUM
Primary settling tank
PRIMARY SLUDGE
Aerating tank
Secondary settling tank
Activated biological sludge is settled out and returned to the aerating tank or removed for further processing.
RETURN SLUDGE
Air and sludge (tiny particles from sewage containing bacteria that eat pollution) are mixed with dirty water.
WASTE SLUDGE

Some Facts about Ground Water

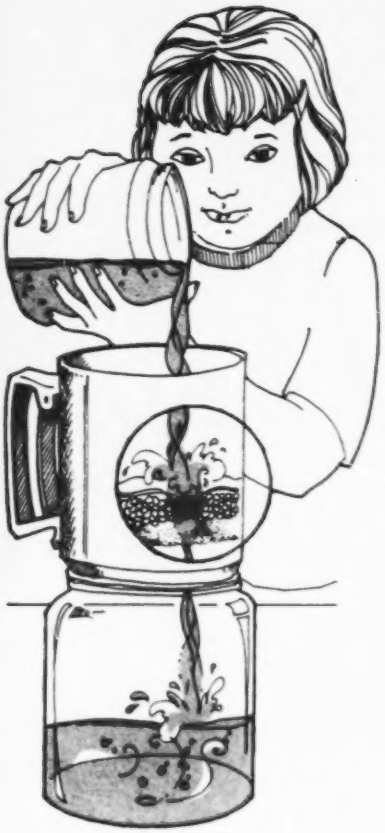
Ground water is underground. You cannot see it, but it is still very important:

- About half of all the people in the U.S. get their drinking water from ground water sources.
- Americans use about 90 billion gallons of ground water every day. Most of this is replaced by rainfall.
- In the U.S. most ground water is used for agricultural purposes like irrigation. Only 14 percent of U.S. ground water is used for drinking.
- Even though it is underground, ground water is not protected from pollution. Dangerous chemicals that are on the surface of the land or buried underground can seep into ground water and pollute it. Contamination can also come from mines, highway salts, fertilizers, abandoned oil wells, gasoline spills, and dozens of other sources.




Tertiary treatment
Manmade chemicals are removed.
Disinfecting tank
Chlorine or other chemicals are added to kill germs. Then water goes to waterway. Primary treatment removes about 30% of pollutants. Secondary treatment removes up to 90% of pollutants.

Water goes directly to disinfecting tank unless tertiary treatment is required.



Experiment

Learn more about how water is treated by cleaning it yourself.

You will need:

A flour sifter, or homemade container with a screen bottom

Absorbent cotton

Coarse, clean sand

Clean gravel

A large glass jar

Muddy water

Cover the screen at the bottom of the sifter or container with a layer of cotton, next a one-inch layer of the coarse sand, then a one-inch layer of the gravel. Set the sifter over the jar. Slowly pour muddy water into the sifter. Look at the water when it comes out the bottom of the sifter into the jar. Is it still muddy? (Note: Don't drink the water. It may look clean, but it still has germs.) Compare what you did with what wastewater treatment plants do, as shown on page 3.

Other Activities

- Do you waste water in your home? Wasted water flows into sewers and must be cleaned all over again. Make a list of ways you and your family can save water.
- Make an exhibit for your school or library showing how drinking water is distributed and wastewater is treated in your community.
- Visit a water treatment plant in your community.
- Visit a construction site or a gas station after a heavy rain. Look at the ground to see if the rain has washed dirt away from the site, or oil away from the gas station, into the street. Find out where the runoff of dirt or oil goes, and if anything can be done to stop the runoff.
- Draw a map of your community showing sources of water pollution.

Answers to questions at beginning of chapter:

1. If yours is like the average American family, you use about 160 gallons of water a day. You drink some of this water. But you also use gallons and gallons for bathing, cooking, washing the dishes and the laundry, brushing your teeth, watering the plants, flushing the toilet, and filling your squirt gun.

2. It takes about 60,000 gallons of water to make one ton of steel.

Environment Crossword Puzzle

"Crossword" means that the words cross each other.

Some words go "across".

Some words go "down".

T
H
LIKE
S

What is the missing word in each sentence below?

Find the number of each word in the puzzle.

The FIRST letter of that word goes in the box with the number.

Across words

"Every litter bit _ _ 1 _ _."

Trash tossed away where it doesn't belong is called _ _ 3 _ _.

The _ _ _ _ 8 _ _ _ _ is what every living thing needs for life. (Already filled in)

_ 9 _ are good to use for cleaning. Save them.

_ _ _ 13 _ _ _ needs to help keep the environment clean.

Each living thing must have _ _ 14 _ to survive.

Dirty water from factories can kill _ 16 _.

People, animals, and _ _ 18 _ _ live on earth.

When you run the shower too long, you _ _ 21 _ _ 22 _ _.

When something like garbage or dirty water is not nice to look at, it is _ 23 _.

Emissions from _ 24 _ can make the air dirty.

Down words

When you leave a room, _ 2 _ _ 11 _ the lights to save energy.

Paper is made from _ _ 4 _ _.

The air and water now on _ _ 5 _ _ have always been here; no new supplies come from space.

The environments of many wild _ _ _ 6 _ _ _ have been hurt by man.

Loud _ _ 7 _ _ bothers people and hurts their ears.

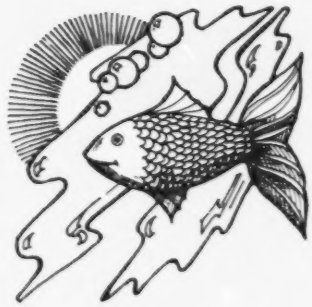
Don't throw away good, used items you no longer need. _ 10 _ them _ 19 _ so others can use them.

Too many _ _ 12 _ _ have hurt the environment.

Living things need fresh _ 15 _ in the environment.

Many birds eat _ _ _ 17 _ _ _.

Save resources; don't be a _ 20 _. (Already filled in)



Solution to crossword puzzle on last page.

CHAPTER 2

Mission: Protect The Air

Try these questions (correct answers on page 8):

1. What is smog?

2. If you live far away from factories and traffic, are you safe from air pollution?

Air pollution

Have you ever heard someone say he is going outside "to get a breath of fresh air?" Have you ever tried to imagine what life would be like if the air were so dirty that people couldn't "get a breath of fresh air?"

How does air become dirty? Your car produces emissions that go into the air. The factories that made materials for your car produce more emissions. All over the world, millions of cars and millions of factories emit soot, ashes, and chemicals into the air. Still more of these substances come from garbage that is burned and chemicals that are sprayed.

The result is air pollution. Sometimes you can smell pollution and sometimes, when the air looks hazy or smoky, you can see it. But sometimes it's invisible.

Invisible or not, air pollution can cause a lot of damage. Even a little air pollution can make your eyes burn and your head ache. It can tire you out, blur your vision, make you dizzy, and make it hard for you to breathe. Air pollutants can also affect asthma and make it easier for you to catch a cold or the flu. And air pollutants have been linked to some cases of serious disease such as lung cancer and heart ailments. In fact, some scientists believe that air pollution costs Americans billions of dollars a year in doctor bills and unearned paychecks due to pollution-related illness.

People are not the only ones hurt by air pollution. Plants surrounded by polluted air may not grow. Fish and animals may die. Statues and building materials may be discolored or *corroded* (eaten away).

Fighting air pollution

In the United States, people have been fighting air pollution for years, and their efforts are working.

Industries must now control emissions from factories. New technology cuts down emissions and removes pollutants from emissions.

Cars now come equipped with something called a "catalytic converter" for the engine system. The converter changes the harmful hydrocarbons and carbon monoxide that a car produces when it burns fuel into harmless carbon dioxide and water. Since a car with a converter uses unleaded gas, converters also reduce lead levels in the air.

Some states and communities require emission control systems in cars to be inspected every year to make sure they are working properly. This discourages drivers from removing catalytic converters from their cars, or from pumping leaded gas into a car that should use only unleaded gas. In most states, it is against the law to switch from unleaded to leaded fuel, or to tamper with catalytic converters.

Thanks to these different kinds of emission controls, the air in the United States is better than it used to be. Amounts of most major air pollutants have gone down. For example, between 1975 and 1984 amounts of carbon monoxide and sulfur dioxide in the air dropped an average of more than 30 percent. The amount of lead dropped 70 percent. Today you *can* go outside "to get a breath of fresh air" in more and more places in the U.S.

New problems

Air quality is improving, but more work needs to be done. Scientists now believe that some problems are more serious than they first thought.

For example, researchers are studying harmful effects of *acid rain*. When some emissions from factories and cars mix with sunlight and vapor in the air, they change into acidic compounds. These compounds can travel long distances in the air. Then they can fall to earth with rain, snow, or dust. When they fall on lakes, they can turn the water acidic, like vinegar. In some lakes, all the fish died because the water became so acidic.

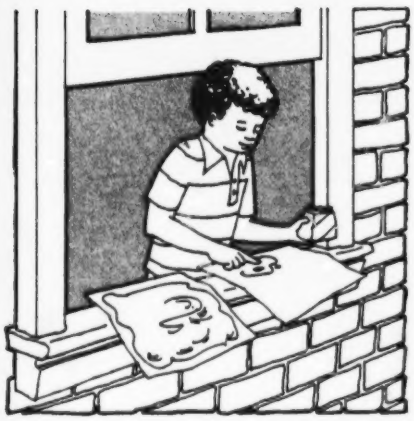
Another problem scientists are learning more about is *indoor air pollution*. The air inside your house may be more polluted than the air around a factory! Indoor air pollution can come from oven fumes, hair spray, cigarette smoke, insect sprays, fingernail polish, carpet cleaners, and other ordinary household products. Even the dirt and rocks around a house can cause pollution, if they contain *radon*. Radon is a radioactive gas which occurs naturally in some soil. It is colorless, odorless, and tasteless, but some scientists believe it causes lung cancer.

Sometimes the simplest cure for indoor air pollution is just to open a few windows. More complicated methods may involve installing exhaust fans or plugging up holes in a house foundation so radon cannot seep through.

Answers to questions at beginning of chapter:

1. Smog—a word that comes from combining the words "smoke" and "fog"—is made up mainly of ozone. That is a gas formed in the air by reactions of chemicals from car and factory emissions. There is smog in lots of cities without much industry. Cars and trucks are largely responsible for that smog.

2. You are not necessarily safe, because air pollution travels. It is carried along by wind and weather. In fact, air pollution that starts in one place often falls to earth hundreds of miles away, in a different state or even in a different country.



Experiment

Find out how dirty the air is in your neighborhood.

You will need:

3 sheets of white paper or cardboard

Petroleum jelly

Smear two sheets of paper on one side with petroleum jelly. Put the sheets next to each other, smeared sides up, on a window sill, and clamp the sheets in place with the closed window. Or tape them to the outside of the window. Do this when it is not raining or snowing.

Take one sheet in at the end of one day and see how dirty it looks (compare it to a clean sheet of paper). Save the dirty sheet. Take the other sheet in after a week. See how dirty it is (compare it to the first dirty sheet and the clean sheet). How dirty do you think the air is?

Other Activities

- Cut down on your car trips; even with pollution controls, cars still emit some pollutants. When possible, walk, bike, or take a bus instead of driving. Help organize carpools for group trips.
- Take pictures of some buildings or statues in your community. At your local library or newspaper office, look up old pictures of the same buildings and statues. See if they have changed over the years. Find out if the change is due to air pollution.
- Draw a map of your community showing sources of air pollution.

Possible Health Effects of Major Air Pollutants

- Lead: Affects the kidneys, nervous system, and all blood-forming organs.
- Carbon monoxide: Weakens heart contractions, reducing the amount of blood pumped through the body. Reduces oxygen available to muscles and organs. Can affect mental function, vision, and alertness.
- Particulates: Irritate the respiratory system.
- Ozone: Irritates eyes, nose, and throat. Reduces lung function.
- Nitrogen dioxide: Irritates the lungs, causes bronchitis and pneumonia, lowers resistance to respiratory infections like the flu.
- Sulfur dioxide: Irritates the respiratory system.

FLANAGAN

CHAPTER 3

Mission: Protect The Land

Try these questions (correct answers at end of chapter):

1. Where does most of the hazardous waste in the U.S. come from?

2. Which one of the following pieces of trash cannot be recycled?

An empty ketchup bottle

Yesterday's newspaper

An empty soft drink can

An old electrical transformer

The metal plate at the bottom of a cardboard juice can

Hazardous wastes

Your favorite sweater has just been dry cleaned. It looks great. All the spots are gone. But it smells funny.

At a gas station, you watch an attendant fill up a car's gas tank. The tank overflows. Gasoline spills onto the ground.

Gasoline and dry cleaning solvents that "smell funny" are important. They give us some of the things we want: clean clothes, and fuel to drive from place to place. But if dry cleaning solvents, gasoline, and thousands of other chemical compounds are spilled, or stored, or dumped improperly, they can become "hazardous wastes."

Something becomes a *waste* when it cannot be recycled, or used again. A *hazardous waste* is a waste that is toxic (poisonous), or that can catch fire, corrode other materials, or react with other chemicals.

Hazardous wastes can pollute the land. They can even pollute the water that is underneath, or next to, the polluted land.

Over the last 40 years, American industry has developed new chemicals to make new products. For a long time, companies got rid of the wastes that came from making these products by dumping them or burying them in the land. People didn't realize that this could be dangerous.

Today we know better. At old dumps and disposal sites across the United States, hazardous wastes could threaten public health and the environment.

And hazardous waste is not going to disappear. Every year, about 65,000 companies or company units make or transport more than 250 million metric tons of hazardous waste!

Americans want medicines, computers, cars, jewelry, insect sprays, paint, and other products. So what can we do about the hazardous wastes that come from making these products?

Fighting hazardous waste

Beginning in 1990, it will be against the law to get rid of most hazardous waste in land, unless land disposal of the waste is safe, or unless the waste has first been treated. Treatment can remove the hazards from hazardous waste. Scientists are studying different treatment methods to find out which ones work best. Possible treatments to destroy hazardous waste include incineration (burning), and use of bacteria or chemicals.

But companies that don't create hazardous waste in the first place don't have to worry about how to treat it. With the land disposal ban coming up, many companies are trying to figure out ways to create *less* hazardous waste.

Other companies are working on ways to recover hazardous materials and use them again. By changing a pollutant into a resource, a company can save money and protect the environment at the same time.

As for the old dumps and disposal sites where hazardous wastes have already done their damage, the country is working to clean them up. Have you ever seen newspaper pictures of people dressed in funny-looking rubber "space suits" poking long sticks into messy barrels? Those people are taking samples of the contents of the barrels. Their rubber suits help protect them in case the contents turn out to be dangerous. The samples they take will be studied in laboratories to find out exactly which hazardous substances or chemicals are inside the barrels. Then the contents will be disposed of safely.

Solid waste

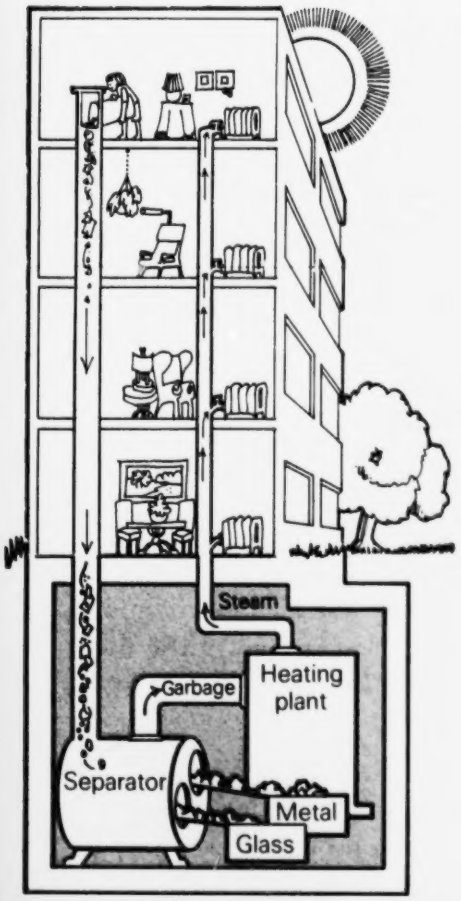
"Solid waste" generally refers to the paper, aluminum cans, glass jars, plastic bottles, spoiled food, broken TV sets, old stoves, junk cars, and other trash and garbage that people throw away. Every year in the U.S., garbage trucks collect about 132 million tons of solid waste! What should we do with all of it?

If we toss the stuff away carelessly, it litters streets, highways, the countryside, and waterways.

If we burn it in the open, it pollutes the air.

If we leave it in the open at garbage dumps, it smells, looks ugly, and attracts rats and insects.

If we bury it, we lose the value of materials in it that might be recycled.



Open garbage dumps (where most of our solid waste goes) improve when they are turned into *sanitary landfills*. In a sanitary landfill, a layer of soil applied daily over the waste keeps pests away and keeps pollutants from washing off the site after rain. The soil layer also prevents litter from blowing away, and does away with the need to burn the waste.

To recycle solid waste and reclaim what is of value is an important goal. It is probably the best method of waste disposal because it allows materials to be used again. Otherwise, solid waste is really wasted solids.

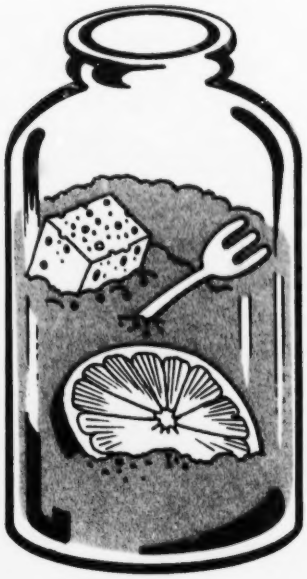
There are many reasons why we don't recycle and recover more solid waste today. We don't know how to recycle some wastes, such as certain plastics. And it often seems easier and cheaper just to throw things away. But the cost of hauling, disposing of, and replacing throwaways is going up.

Some garbage that cannot be recycled or reclaimed now can be burned to produce energy. When burnable and non-burnable wastes are separated, the burnable waste can be mixed with coal and used as fuel in electric utility boilers.

Note in the picture (left) how garbage can be collected and some of it burned to heat a building, while metal and glass that does not burn is recovered.

One way to reduce the solid waste problem is to produce less solid waste. Do we really need all the cellophane, cardboard,

colored paper, metal foil, and plastic bags that so many things come wrapped in?



Experiment

Make a miniature sanitary landfill.

You will need:

A large container, such as a glass jar or milk carton

A piece of fruit or vegetable, such as a slice of tomato or an apple core

A small piece of plastic, such as a plastic fork or part of a broken toy

Soil

Place some soil in the bottom of the container. On top of the soil, place the piece of fruit and the piece of plastic. (You can add other things too, like a small piece of aluminum foil or a small piece of styrofoam.) Add more soil on top of these items. Put the container in a warm place, and keep the soil damp. After one week, and again after another week, check to see what has happened to the fruit and the plastic and any other items you buried in the soil. Does the fruit look different than it did when you buried it? Does the plastic look different? Some things come apart, or *decompose*, in the environment. Other things *persist*, or last for a long time. Which do you think is more harmful to the environment? (Note: If you are allergic to mold, don't handle the mold that may have grown on the fruit.)

Other Activities

- Recycle some solid waste in your home. Use an empty egg carton to store small items. Clean and decorate a can or jar for use as a vase or pencil holder. Use the blank side of printed paper for scrap paper. Think of other "throwaways" in your home that can be used again.
- Organize your friends or classmates into a recycling club. Gather such things as newspapers, aluminum cans, or glass bottles for sale to companies that will recycle them. Or gather large discarded cardboard boxes for sale to people who are packing up to move.
- Draw a map of your community showing sanitary landfills for garbage, hazardous waste dumps, and factories that generate hazardous waste.

Answers to questions at beginning of chapter:

1. Most of the hazardous waste in this country comes from industry. And most of industry's hazardous waste comes from chemical companies.

2. The old electrical transformer cannot be recycled if PCBs are in its cooling system. PCBs are a dangerous chemical. All of the other trash can be recycled, using a fraction of the energy that would be needed to make the products from scratch.

21

CHAPTER 4

Mission: Safer Use of Pesticides

Try these questions (correct answers at end of chapter):

1. What is the most important thing to do before using a pesticide?

2. How many pesticides are now registered in the U.S.?

Pesticides and you

Farmers use pesticides to keep bugs, mice, and other pests from destroying their crops. If you are not a farmer, you will probably never come into contact with pesticides, right?

Wrong.

Have you ever eaten an apple or a peach or a potato? Pesticides were used to help grow those fruits and vegetables, and traces of the pesticides may be inside or on the skin.

Have you ever watched someone give a pet shampoo to a scratching dog to kill its fleas? Pesticides were in the flea bath.

Have your parents ever aimed a can of bug spray at a pesky cockroach or mosquito, or used a can of disinfectant to clean a dirty bathtub? Pesticides were in both those cans.

Pesticides are chemicals that kill pests. People use them to kill harmful insects, weeds, and animals like mice and rats.

Thanks to pesticides, some insect-related diseases like malaria have been nearly wiped out, and crops have been saved from destruction. Thanks to pesticides, America has become a land of agricultural plenty.

But pesticides, because they are poisons, can also be dangerous. Particles of sprayed pesticides can float into the air. When it rains, other particles can wash off plants to the ground, and from there into ground water. No matter where the pesticides end up—in the air, on land, in water, or on the crops where they were first applied—pesticides can cause harm.

Farmworkers who use pesticides run the highest risk. If the pesticide touches their skin, or if they breathe fumes from pesticide spray, they can be poisoned. Some researchers think that hundreds of thousands of farmworkers in the U.S. suffer from pesticide poisoning every year.

People who drink water contaminated with pesticides, or who eat food that contains traces of pesticides (called *residue*) may also get sick. Some pesticides can cause cancer and birth defects in people.

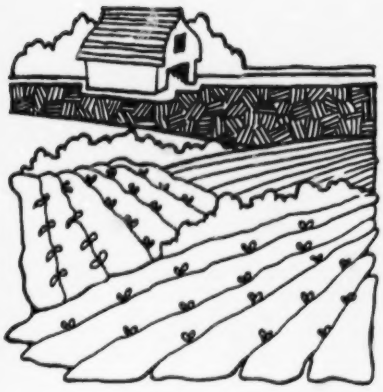
Even wild animals can die if they eat crops or smaller animals that have come into contact with pesticides.

The "R" factor

People use 10 times more pesticides today than they did 40 years ago. Even so, insects cause more crop damage now than they did then. Why?

Because, over time, "superbugs" develop which can resist killer chemicals. This resistance is known as the "R" factor.

Scientists have identified more than 400 insect pests that can resist one or more pesticides. They have found about 150 species of bacteria and fungi, more than 50 species of weeds, and several species of rodents that have also developed pesticide resistance.

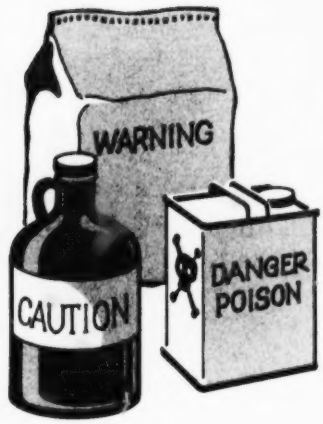


When a new pesticide is substituted for an old one, pests often come to resist the second pesticide as well as the first.

Since the pesticide payoff is unpredictable, people are looking for better ways to control pests. Sometimes they bring in natural enemies to eat the pests. Wasps, for example, were used to destroy walnut aphids that once threatened California's walnut groves. Other pest-controlling insects have been used to save sugar cane in Hawaii, grain in Michigan, apples in New York, and oranges in Florida.

Other methods also help. "Trap crops"—disposable decoys--draw pests away from main crops. Careful breeding produces strong plants that resist pests. Artificial sex smells lure pests into sticky traps. Radiation or hormone treatments stop pest reproduction. Early harvesting bypasses some pest life cycles completely.

Use of all these different methods together is known as "integrated pest management." That's a fancy name to describe a simple goal: as much as possible, control pests naturally instead of chemically. With integrated pest management, pesticides will still be used, but more carefully and less often.



Protect yourself from pesticides

Never use pesticides yourself!

It is dangerous, and it is against the law, for children to use pesticides. In fact, some pesticides come in child-proof containers. Pest control with pesticides is a job for adults.

Learn to recognize a pesticide by the label on the container. But avoid touching or using pesticide containers, even if they are empty. Spilled pesticides on a container can poison you.

Three kinds of pesticide labels are pictured to the left. Each has a key word you should look for:

DANGER

WARNING

CAUTION

Should you or someone else be accidentally poisoned by a pesticide, follow the directions on the pesticide label about what to do.

The "R" Factor: Talk about Extremes!

Sometimes an insect does more than develop resistance to a pesticide. It grows to depend on the pesticide. A species of bee in Brazil actually *eats* the pesticide DDT!

Normally, a deadly dose of DDT for bees is 6 parts per million. Scientists have found that the bees in Brazil accumulate DDT in their bodies to concentrations as high as 42,000 parts per million. That is more than four percent of the bee's total body weight! Yet the bees show no ill effects from the DDT.

Experiment

Observe how a food chain works.

You will need:

A container such as a glass aquarium, clear plastic shoe box, or large, wide-mouthed glass jar

Seeds of clover, grass, mustard, or pea

Pebbles or sand

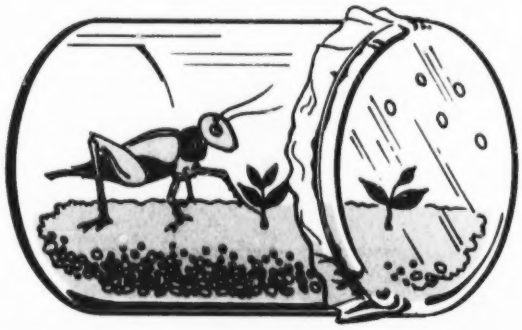
Soil

Water

Plastic wrap

Crickets

Chameleon



Put a layer of sand or pebbles at the bottom of the container, then a layer of soil. (If you are using a large jar, lay it on its side.) Moisten the soil with water. Plant the seeds. Cover the container tightly with plastic wrap. Then put it in a place that is sunny, but away from direct sunlight and direct heat.

After the seeds have grown, punch airholes in the plastic wrap and add a few crickets. Do they eat the plants? Add the chameleon. Does it eat the crickets? The food relationship between plants, plant eaters, and animal eaters is called a *food chain*. If the plants had been sprayed with a pesticide, what could happen to the bugs that ate the plants? What could happen to the animal that ate the bugs? (Note: If you don't have the materials for this experiment, you can observe plant-eating insects and insect-eating animals like birds or frogs outdoors.)

Other Activities

- Pick a landscaped area around your school or home. Ask the person in charge what pesticides are used on the area. Find out what chemicals are in the pesticides. Visit the landscaped area when it is raining. Find out where the water running off the area goes. Could the runoff contain traces of pesticides?
- Adopt a tree. Weed it to remove hiding places for pests. Water it in dry weather to keep it strong and resistant to pests.
- If you have a garden at home or school, try keeping it pest-free without pesticides. Wearing gloves, pick off larger pests like caterpillars and Japanese beetles with your hands. Hose the plants with water to wash pests off.
- Do not harm ladybugs, praying mantises, spiders, toads, and birds. They help control insect pests.
- Wash fruits and vegetables well before eating them.

Answers to questions at beginning of chapter:

1. The most important thing to do before using a pesticide is to *read the label* and *follow directions.*

2. About 45,000 pesticides, made from one or more of about 1,400 chemical compounds, are now registered in the U.S.

HEALTH AIDS
COLD REMEDIES
2
CLEANSERS
DISINFECTANTS
SALE
BLEACH

CHAPTER 5

Mission: Safer Use of Toxic Substances

Try these questions (correct answers at end of chapter):

1. Are all chemicals toxic?

2. Which of the following products contain, or used to contain, toxic chemicals?

Children's pajamas

Roof shingles

Paint

Car brake linings

Carbonless copy paper

Toxic substances

Have you ever used a bottle of glue? Or been in a room with ceiling tiles? Or taken medicine for a sore throat?

Chances are, you have done all these things. But you probably did not know that the glue and the tiles and the medicine contained toxic, or poisonous, substances.

Toxic substances are found in thousands of useful, everyday things. In final form, in your house, most of these products are safe if used correctly. But in the environment, the toxic substances that make up some of these products can be dangerous, even deadly.

How much is too much?

Today, scientists can measure smaller amounts of toxic substances than ever before.

Suppose you accidentally spilled a few drops of orange juice into a large swimming pool. After a few hours, the few drops of juice would be spread throughout the hundreds of thousands of gallons of water in the pool. Next, suppose you scooped up some water from the pool into a clean cup. You wouldn't be able to see, taste, or smell the juice.

If you tried to reach a ratio of 50 parts of juice per trillion parts of water, you would have to spread your few drops of juice through 20 swimming pools!

How much is too much? In the case of orange juice, a few drops in a swimming pool is not important. But if the substance in the water were dioxin instead of juice, a few drops could be very dangerous.

With modern technology, scientists can now discover very, very small amounts of dioxin and other toxic substances—amounts as small as 50 parts per trillion—in soil, water, food, and consumer products.

A person who eats a fish with 50 parts per trillion of dioxin runs a health risk. Is the risk worth it? For most people, the answer is no, because there are many other things for them to eat besides that fish.

A person who takes medicine for cancer also runs a risk. The medicine may cause other sickness. Is the risk worth it? For most people, the answer is yes, because the cancer is probably worse than the other sickness.

In the case of toxic substances, people have to decide whether the risks involved are worth it.

Toxic "Hit List"

If someone were to make up a "hit list" of toxic chemicals, dioxin, polychlorinated biphenyls (PCBs), ethylene dibromide (EDB), and asbestos would probably be on the list.

Dioxin is a waste byproduct from the manufacture of herbicides that are used to kill weeds. Scientists have a lot to learn about the effects of dioxin. They already know that it can cause cancer in test animals, and skin disease in people. Dioxin can be destroyed by incineration (burning).

PCBs, which are heat resistant, were once used in certain kinds of electrical equipment. PCBs may cause cancer and birth defects in animals. Production of PCBs is now banned in the U.S.

EDB is a pesticide that has caused cancer and birth defects in test animals. Use of EDB on grain, fruit, and soil has been banned in the U.S.

Asbestos is the name for a group of natural minerals (silicates) that separate into thin, strong fibers. Asbestos, which is heat resistant, was once sprayed on ceilings to make them fireproof, and was also used in hundreds of other products. When asbestos breaks down into a dust, it can be breathed in, and can cause cancer and lung disease. Use of asbestos in many products may soon be discontinued.

Experiment

Find out how some substances can be toxic to living things.

You will need:

2 containers, such as flower pots or plastic cups

2 plants, or 2 seeds (bean seeds are easy to handle)

Soil

Salt

Water

Place soil in the containers. Put one plant, or one seed, in each container and place in a sunny spot. Keep the soil moist. (If you use seeds, wait until they grow before continuing the experiment.) Water one plant regularly with ordinary tap water. Water the other plant regularly with a combination of tap water and salt. What happens to each plant? What does this tell you about the effect of certain substances on living things?

Answers to questions at beginning of chapter:

1. No. About 63,000 chemical substances are used in the U.S. Of these, only a small percent pose a toxic risk to health or the environment.

2. All of these products once contained toxic chemicals. In the 1970's, children's pajamas were flameproofed with a chemical called Tris. Roofing shingles and car brake linings are made with asbestos (although use of asbestos may be banned soon.) Carbonless copy paper and some paints were once made with polychlorinated biphenyls (PCBs).

Word Search

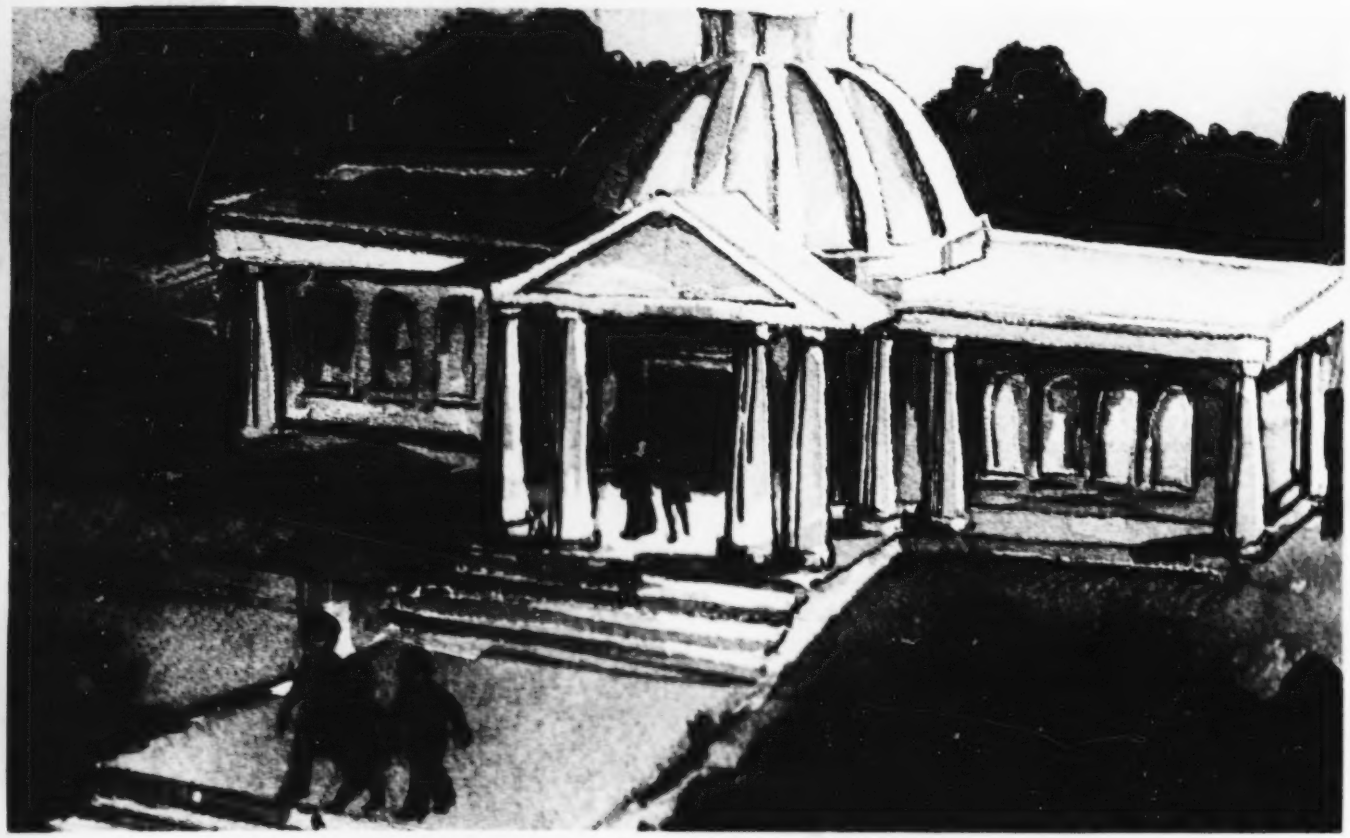
How many of the following words can you find in this puzzle? Each word may be spelled forwards, backwards, downwards, or diagonally. One word is spelled diagonally backwards. Answers to puzzle on last page.

environment
pollution
groundwater
runoff
recycle
smog
emissions
radon
lead
ozone
corrode
waste
hazardous
litter
incinerate
decompose
pesticide
water
toxic
dioxin
asbestos
discharge
standard
dump
chemicals
lab
air
earth
land
rain
dispose
health
acid
smoke
residue
risk

D E D I S P O S E N D N A L N I S L I L
Y R A U T L D I N A E M I S S I O N S H
S I E T A R E N I C N I D N B M E Y H A
N F F O N U R N A A V H E L E E O A N O
R S U O D R A Z A H I H A R O L S K D S
O P H I A U I E C O R R O D E B I T E L
L N I A R Y M S P E O A R L S L I C O K
S O U T D E H P K P N O I T U L L O P S
E N M A R G S H E R M R I H T L A E H T
C L X R A V E I T R E T A W B F K R A A
H W M B L D J O D T N Q V U N I X O I D
B E I N Q F Z A A U T O X I C G J N P I
T A L E T S A W S U E S A N H C A R O S
L Y I A N C D E C O M P O S E H A N D C
E L T L B N E G E R T E T S M O G T I H
E R T E U O Y J U S T I N A I N T H O A
N Y E O Y Z M I C P E S T I C I D E C R
K E R A D O N Y H O W A R D A D A I V G
I G D J A N C K D R E C Y C L E D O T E
J H T R A E E R R Y M A R C S I A K A R

APPENDIX A

EPA and Environmental Laws



To help fight pollution, the U.S. Environmental Protection Agency, or EPA, was created in 1970. It works with other federal agencies, state and local governments, business firms, and ordinary citizens on environmental problems. EPA acts under laws of the U.S. Congress.

EPA's main mission is to set and enforce environmental standards. These are limits on how much pollution can be allowed without hurting people's health and welfare. To determine what the standards should be, EPA conducts research on effects of pollution.

Since pollution problems in one part of the country sometimes differ from those in other parts, state and local governments have to decide for themselves what pollution to control and how to control it. EPA helps by providing new information and by funding projects like sewage treatment plants.

But on the big problems of national pollution, EPA makes sure that the same rules are followed all over the country.

Water

Clean Water Act

This law aims to restore and maintain water quality in rivers, lakes, and wetlands. The law is carried out by EPA and the states.

- Each state sets water quality standards for its own waters based on how it plans to use those waters (for swimming, fishing, drinking, etc.).
- When a city or an industry wants to discharge wastewater into a river or stream, it must have a permit that limits the amounts of pollutants it is allowed to put into the water.
- EPA and some states issue these permits and then check on the dischargers to make sure they are meeting the limits in their permits.
- Wetlands areas like swamps and marshes cannot be filled in with dirt unless EPA approves of the action.

Under the *Safe Drinking Water Act*, EPA sets national standards to protect drinking water.

Under the *Marine Protection, Research and Sanctuaries Act*, EPA regulates dumping of wastes in the ocean.

Air

Clean Air Act

This law authorizes EPA to protect the public health and welfare from bad effects of air pollution.

- EPA sets standards for six major pollutants. The standards are limits on the amount of each pollutant that can be in the air. The six pollutants are sulfur oxides, nitrogen oxides, carbon monoxide, ozone, particulates, and lead.
- EPA sets special, stricter standards for areas with very clean air, so that it won't become dirty.
- EPA sets standards to control emissions of very toxic substances such as asbestos, berylium, mercury, and vinyl chloride.
- EPA sets emission standards for different sources of air pollution. For example, EPA sets limits on emissions for new cars, new factories, and old factories that are being fixed up.
- EPA reviews each state's plan for clean air. If the plan isn't good enough, EPA can require that it be improved.

Wastes

Resource Conservation and Recovery Act

This law authorizes EPA to work for safe disposal of solid and hazardous waste. It also encourages recycling.

- EPA works with the states to check on the safety of all solid waste disposal sites and to shut down open dumps.
- EPA tracks the movement of hazardous wastes from the places where they originate to the places where they are disposed of. Treatment, storage, and disposal sites must prevent wastes from reaching soil and water. Otherwise, they will not be permitted to operate.

  EPA must decide if it is safe to continue disposing of certain wastes in the land. If EPA misses the deadlines for these decisions, land disposal of the wastes must automatically stop.

  EPA must establish standards for tanks that store hazardous materials underground.

  EPA must establish better standards for places where hazardous waste is stored *on* the ground. (These places are called landfills, surface impoundments, and waste piles.)

Comprehensive Environmental Response, Compensation and Liability Act (also known as Superfund)

This law authorizes EPA to respond to waste problems that endanger public health or the environment.

- EPA, state governments, or those who caused a hazardous waste problem must clean up abandoned dumps, oil spills, and other spills of hazardous materials.
- Cleanup costs can come from a special fund. Most of the money in the fund comes from a tax on companies that manufacture certain chemicals and petroleum.
- EPA makes a National Priorities List of hazardous waste sites that qualify for long-term cleanup action. Hundreds of sites across the country are on the list.

Pesticides

Federal Insecticide, Fungicide and Rodenticide Act

- People and firms that make pesticides must register them with EPA before they can sell them in the U.S.
- Pesticide makers must prove that their products affect pests the way they say they will, and that the products, when used as directed, will not harm people, livestock, wildlife, or crops.
- EPA decides whether a pesticide can be used in *general* or *restricted* ways. People who apply restricted (very dangerous) pesticides must get special training.
- EPA sets standards for making sure that pesticide applicators are qualified to use restricted pesticides.
- The EPA Administrator can cancel or stop registration of pesticides that are harmful to people, livestock, wildlife, or crops.
- All pesticide containers must be labeled according to ways developed by EPA (see Chapter 4).

Under the *Federal Food, Drug and Cosmetic Act*, EPA decides on safe levels for pesticide residues in food and animal feed.

Toxic Substances

Toxic Substances Control Act

- EPA can require tests of new chemicals to find out if they cause cancer, birth defects, or have other harmful effects.
- EPA keeps an inventory of chemicals used in business in the U.S. Chemicals that are not on the inventory cannot be made in, or brought into, the U.S. before EPA reviews them.
- EPA can stop companies from making, selling, using, or throwing away any chemical. It can do this if it finds that the chemical endangers health or the environment.
- EPA sets standards for laboratories that test chemicals.

APPENDIX B

Dictionary of Environmental Terms

Acid Rain: Precipitation (rain, snow, sleet, or hail) which contains water more acidic than normal. Caused by reactions of chemicals in the atmosphere.

Aquifer: An underground layer of earth, gravel, or porous stone that contains water.

Atmosphere: The body of air surrounding the earth.

Ban: To prohibit, or not allow, something.

Biodegradable: Able to be broken down into simpler products by microscopic plants and animals.

Byproduct: A secondary product of a manufacturing process. A *waste byproduct* is an unwanted byproduct that can either be disposed of or recycled.

Catalytic converter: A device in cars that reduces air pollution by changing harmful contaminants into harmless carbon dioxide and water.

Compound: Made up of two or more parts or elements.

Conservation: Not wasting, and renewing when possible, the human and natural resources of the world.

Contaminate: To pollute something, or make it dirty.

Decompose: To break down and change in both chemistry and appearance through the action of bacteria.

Dispose: To get rid of something. Methods to dispose of hazardous waste include burning it and burying it.

Ecology: The study of relationships between living things and their surroundings.

Emissions: Waste materials that are discharged into air. Sometimes emissions are treated, or cleaned; sometimes they are not.

Environment: Everything, including living things, that surrounds a person, animal, or plant.

Erosion: The wearing away of land surfaces by the action of wind or water.

Ground water: The supply of water under the earth's surface that forms natural reservoirs.

Hazardous waste: Ignitable, corrosive, reactive, or toxic waste that needs special care in disposal.

Incinerator: A furnace that burns under controlled conditions.

Mobile source: A moving source of pollution, such as a car or truck.

Persist: To live on, to last for a long time.

Pollute: To make the land, water, or air dirty and unhealthy.

React: To act in response to something. For example, a chemical can change, or react, if added to another chemical.

Recycle: To reuse waste materials.

Register: To obtain licensing to sell a pesticide, based on tests that show the pesticide is safe when used as directed.

Residue: Something that remains, or is left over.

Resist: To repel, or withstand, something, as an insect resists a pesticide.

Resources: Air, water, soil, trees, plants, minerals, wildlife, and other things that make up the natural wealth of the earth.

Respiratory system: A body's system for breathing, including the nose, throat, and lungs.

Runoff: Water from rain, melting snow, or irrigation that flows over the ground and returns to streams, sometimes carrying with it pollutants picked up from air or land.

Sediments: Soil, sand, and minerals washed from land into water, usually after rain.

Seep: To leak slowly, as a liquid, through a porous substance such as soil.

Sewage: The organic waste and wastewater that comes from homes, farms, and businesses.

Site: Place or location.

Solid waste: Trash and garbage without enough liquid to flow freely.

Species: A biological classification that includes a single kind of plant or animal.

Standard: Limit on the amount of pollution that can be produced.

Stationary source: A non-moving source of pollution, such as a factory smokestack.

Tamper: To change something, especially for the purpose of damaging or misusing it.

Tolerance: The safe level of a chemical residue in food.

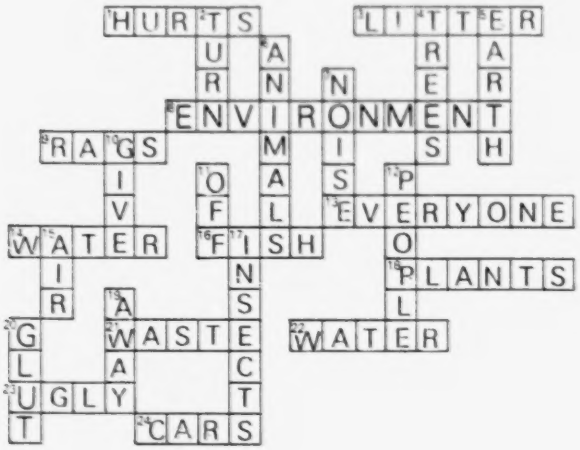
Toxic: Poisonous

Treatment: Use of chemical, biological, or other processes to make waste less toxic or non-toxic.

Wastewater: Water that carries solids, and that comes from homes, farms, and businesses. (See "Sewage")

Wetlands: Water-soaked areas such as swamps, bogs, marshes, and estuaries.

Answers to Crossword Puzzle and Word Search



D E **D I S P O S E** N **D N A L** N I S L I L
Y R A U **T** L D I N A **E M I S S I O N S** H
S I **E T A R E N I C N** I D N **B M E** Y H A
N **F F O N U R** N A **A V** H E L E **E O A** N O
R **S U O D R A Z A H I** H A R O L **S K** D S
O P H I **A U I E C O R R O D E** B I **T E** L
L **N I A R Y M S** P E **O** A R L S L I C **O** K
S O U T **D E** H **P K** P **N O I T U L L O P S**
E N M A R G **S** H E R **M R** I **H T L A E H** T
C L X R A V E **I** T **R E T A W** B F K **R A** A
H W M B L D J O **D T N** Q V U **N I X O I D**
B E I N Q F Z A **A U T O X I C** G J N **P I**
T A **L E T S A W** S U **E** S A N **H** C A R O **S**
L Y **I** A N C **D E C O M P O S E** H A N D **C**
E L **T** L **B N** E G E R T E T **S M O G** T I **H**
E R **T E U O** Y J U S T I N A **I** N T H O **A**
N Y **E O Y Z** M I C **P E S T I C I D E C R**
K E **R A D O N** Y H O W A R D **A** D A I V **G**
I **G** D J A **N** C K D **R E C Y C L E** D O T **E**
J **H T R A E** E R R Y M A R C **S** I A K A R

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